Simulating Extrasolar Planet Populations for Direct Imaging Surveys

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As direct imaging surveys are being designed and carried out to detect extrasolar planets around young, nearby stars it is important to carefully evaluate the criteria for selection of target stars, as well as the predicted success of a given planet-finding system. We have developed a routine to simulate an ensemble of a large number of planets around each potential target stars, and to determine what fraction can be reliably detected using a system's predicted or observed sensitivity curve (The maximum flux ratio between the parent star and a detectable planet as a function of projected angular radius). Each planet has a randomly assigned semi-major axis, mass, and eccentricity (following extrapolations of detected radial velocity planets), as well as viewing angles and orbital phase. The orbital parameters give a projected separation for each planet, while the mass is converted into a flux ratio in the appropriate bandpass of the detector using the models of Burrows et al. (2003); this allows the simulated planets to be directly evaluated against the system's sensitivity curve. Since this method requires basic parameters (age, distance, spectral type, apparent magnitude) for each target star, a target list can be constructed the maximizes the likelihood of detecting planets, or competing instrument designs can be evaluated with respect to their predicted success for a given survey. This method has already been employed to select targets for the Simultaneous Differential Imaging surveys (Biller et al. 2004) conducted at the VLT and MMT.